Bibliometric mapping of the flipped classroom as a strategy for independent learning in students

Mapeo bibliométrico del aula invertida como estrategia para el aprendizaje autónomo en los estudiantes

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Abstract

The flipped classroom model revolutionizes conventional instruction by placing emphasis on the student, who assumes a more active and independent role in the learning process. In this sense, the objective of this study was to conduct a bibliometric mapping of the academic literature on the flipped classroom as a strategy for developing autonomous learning in students, between 2013 and 2025. To do so, a bibliometric approach was applied, selecting 144 Scopus publications with the English keywords "flipped classroom" and "autonomous learning." Variables such as country, author, type of publication, source, and document type were analyzed. The results show growing interest, with a 35.4% increase in publications between 2020 and 2024. China stands out with 35% of the world's scientific production. The journal BMC Medical Education was the most relevant source, with five publications, while Lin was the most cited author, with two articles published in 2018 and 2019 and 174 citations. Furthermore, 93.1% of publications are scientific articles, with social sciences representing the most developed field at 38%. In conclusion, there is a sustained trend in research on the flipped classroom as a method for promoting independent learning, reflected in the diversity of authors, geographic dispersion, institutional collaboration, and production in various thematic areas. This bibliometric analysis thus establishes a solid foundation for future research.

Keywords: flipped classroom, independent learning, student.

Resumen

El modelo de aula invertida revoluciona la instrucción convencional al poner el énfasis en el estudiante, quien asume un papel más activo e independiente en el proceso de aprendizaje. En este sentido, el objetivo de este estudio fue realizar un mapeo bibliométrico de la literatura académica sobre el aula invertida como estrategia para el desarrollo del aprendizaje autónomo en estudiantes, entre 2013 y 2025. Para ello, se aplicó un enfoque bibliométrico, seleccionando 144 publicaciones de Scopus con las palabras clave en inglés *flipped classroom* y *autonomous learning*. Se analizaron variables como país, autor, tipo de publicación, fuente y tipo de documento. Los resultados muestran un creciente interés, con un aumento del 35,4 % en publicaciones entre 2020 y 2024. China destaca con el 35 % de la producción científica mundial. La revista *BMC Medical Education* fue la fuente más relevante, con cinco publicaciones, mientras que Lin fue el autor más citado, con dos artículos publicados en 2018 y 2019 y 174 citas. Además, el 93,1 % de las publicaciones son artículos científicos, y las ciencias sociales representan el campo de mayor desarrollo con un 38 %. En conclusión, existe una tendencia sostenida en la investigación sobre el aula invertida como método para promover el aprendizaje autónomo, reflejada en la diversidad de autores, dispersión geográfica, colaboración institucional y producción en diversas áreas temáticas. Este análisis bibliométrico establece así una base sólida para futuras investigaciones.

Palabras clave: aula invertida, aprendizaje autónomo, estudiante.

Introduction

The development of digital technology and the need to cultivate essential skills in 21st-century students have led to a significant change in educational practice over the last few decades (Salazar et al., 2025). In this context, the development of competencies such as autonomous learning has become highly relevant, as it enables individuals to take control of their own education, adapt to new situations, and continue learning throughout their lives (Vera, 2021; Bonifaz et al., 2022). Furthermore, this approach allows the teacher to focus more on guiding and supporting students during their work, adjusting their support to the particular needs of each individual (Rodríguez, 2024; Rivera, 2021).

For this reason, determining the theoretical foundations of the flipped classroom model represents only the first step in investigating it as a strategy that promotes independent study (Aburto, 2021). Additionally, it is necessary to consider how it could be implemented, its advantages and disadvantages, as well as its impact on student motivation and academic performance (Cedeño-Escobar & Vigueras-Moreno, 2020).

However, the academic literature presents divided positions regarding the influence of the flipped classroom technique on the development of autonomous learning, despite the fact that this active methodology is gaining popularity (Ventosilla et al., 2021). This is compounded by the difficulty in understanding its true impact, due to the lack of exhaustive studies that integrate and evaluate the scientific output related to these themes (Colque & Arias, 2024). This situation complicates the identification of the most prominent methodological approaches, gaps in knowledge, and possible new lines of research (García et al., 2021).

To evaluate the level of understanding regarding the relationship between autonomous learning and the flipped classroom, it is essential to conduct a bibliometric mapping (Sandobal et al., 2021). This methodology allows for observing the evolution of the discipline, identifying the most influential scientists, the contexts that have received the most attention, and the new areas of study that are emerging in the literature (Elera et al., 2023). Moreover, it provides valuable perspectives for educators and researchers interested in successfully adopting this technique, aligning with the goals of student-centered education (Vera, 2022).

Likewise, this study is relevant because it contributes to the understanding of a teaching method that addresses the challenges of current education (Nahuelcura-Millán, 2023). Consequently, the flipped classroom represents an important educational response to the demand for students to be more self-sufficient, critical, and capable of learning independently (Chero-Santisteban et al., 2025; Romero-Carazas et al., 2023).

In this regard, theories of active learning, such as constructivism—which holds that students construct their own knowledge through experience—form the basis of the flipped classroom model (Ordoñez et al., 2021). Additionally, Knowles' self-directed learning method and Zimmerman's concept of self-regulated learning are linked to it, emphasizing the student's ability to intervene in their learning process, design, implement, and evaluate their own progress (Pinto & Palacios, 2022).

On the other hand, bibliometric review constitutes an effective method for analyzing the state of research in a specific field, revealing new directions, gaps in knowledge, and emerging trends (Rodríguez-Pozo & Medina-Chicaiza, 2025). In the case of the flipped classroom as a strategy for autonomous learning, similar bibliometric studies have been conducted in areas such as online education, gamification, and mobile learning (Soler et al., 2024; Bracho et al., 2024; Peña & Moya-Ramón, 2023).

Therefore, through bibliometric analysis, it is possible to trace the development of research on the flipped classroom as an approach to autonomous learning, identify seminal works in this area, and follow the evolution of publications, authors, and universities that have contributed most to its advancement (Zavala et al., 2023). In this way, the bibliometric study aids researchers in mapping the dissemination of knowledge and determining the relative relevance of different publications by evaluating works and other academic outputs (Caló, 2022).

Moreover, databases only fulfill their role of identifying scientific precedents if they collect accurate and reliable research data (Sanz, 2022). In this sense, bibliometric indicators allow for quantifying the amount of literature related to a specific topic or a set of related topics (García-Villar & García-Santos, 2021).

Consequently, researchers have explored the flipped classroom as a strategy for autonomous learning in order to lay the groundwork for a solid theoretical framework in this field. Based on this context, the present work aims to conduct a bibliometric mapping of the academic literature linked to the flipped classroom as a strategy for the development of autonomous learning in students. Thus, the following questions are posed: 1) What are the publication trends in this field according to year, thematic area, and type of document? 2) Which countries, authors, sources, and journals are the most influential in the research? 3) What is the most recurring term in the keyword analysis in studies on the flipped classroom as a strategy for autonomous learning?

Methodology

The purpose of this bibliometric study was to identify academic publications from 2013 to 2025 that addressed the flipped classroom model as a strategy to enhance student autonomy in the classroom. To achieve this, a quantitative technique typical of bibliometrics was applied, a discipline that utilizes mathematical and statistical methods to analyze, evaluate, and objectively represent scientific production, thereby contributing to the establishment of a solid theoretical foundation on the studied topic (Salinas & García, 2022).

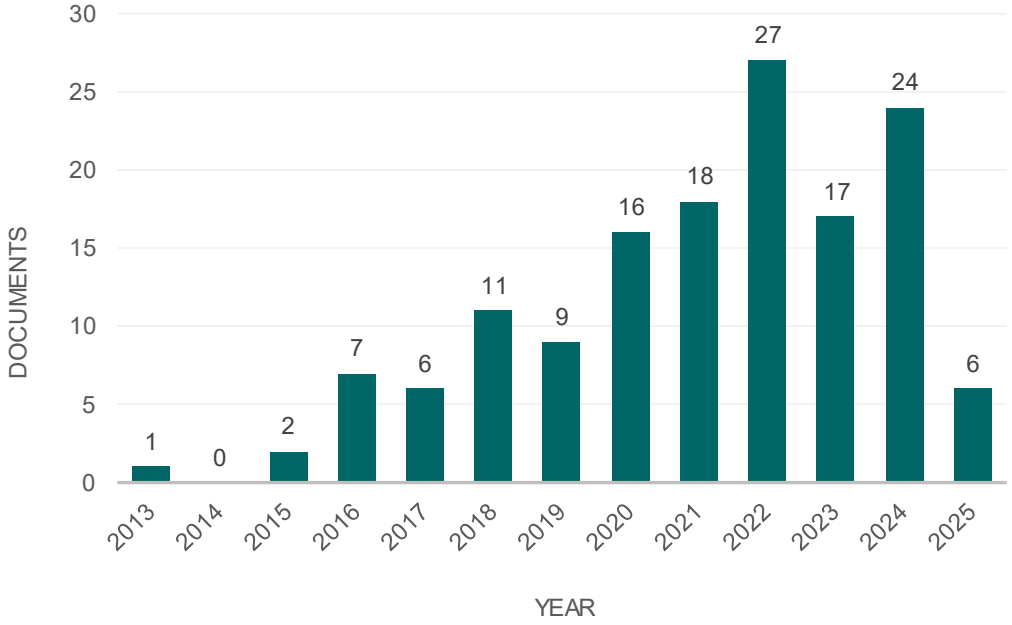
First, a search was conducted using Boolean operators with the English terms "flipped AND classroom" and "autonomous AND learning" to collect data from titles, abstracts, and keywords. Subsequently, after applying filters based on publication type and the temporal range (2013–2025), a total of 144 works were identified. All were carefully selected to ensure their relevance, evaluating indicators such as authorship, country of origin, year of publication, journal or source of publication, document type, keywords, and thematic area (Florez-Fernández & Aguilera-Eguía, 2020).

Additionally, a key component of the research involved a co-occurrence study of keywords, aimed at identifying related ideas and patterns in the published scientific literature. Descriptive statistics were then performed using Microsoft Excel, which enabled the organized and structured presentation of the data. Furthermore, VOSviewer software (version 1.6.19) was utilized for visualizing thematic networks and patterns of relationships between terms, facilitating a deeper and visually accessible analysis.

Results and discussion

The bibliometric analysis covered research works published on the flipped classroom technique as a strategy to foster student autonomy in learning from 2013 to 2025. Notably, from 2020 onward, there was a marked increase in academic production related to this topic, evidencing an exponential growth rate throughout the studied period (Figure 1). However, it is worth noting that the most productive years for the scientific community were 2022 and 2024, concentrating a total of 51 documents, which represents 35.4% of the accumulated global production.

Figure 1
Evolution of publications by year



The most prominent researchers in the field of the flipped classroom for autonomous learning deserve special recognition for their valuable contributions to expanding knowledge in this area. In this sense, the works analyzed in this study were authored by a total of 153 authors from various academic institutions. Table 1 presents the most productive authors, ranked by the total number of publications.

In particular, the most prolific researcher is Lin, C.J., from the National Taichung University of Education (Taiwan), who has two registered publications, 174 citations, and an H-index of thirteen. Similarly, contributions from He, J. (n=2; 56 citations) and Inga, E. (n=2; 55 citations) have also significantly influenced the scientific literature related to the flipped classroom and autonomous learning.

Table 1
Authors with highest scientific productivity

Main author	Quantity	Number of citations	H-index
He, J.	2	56	3
Holland, C.	2	9	6
Inga, E.	2	55	17
Lin, C.J.	2	174	13
Ma, B.	2	0	34
Roman, C.	2	0	13
Sánchez-Compaña, M.T.	2	16	5
Wells, M.	2	9	4
Xing, X.	2	0	6
Abadie, G.D.	1	0	0
Acal, C.	1	14	9
Aghaei, K.	1	31	3
Aizpuru, L.M.	1	1	1

Ajam, F.	1	31	1
Akhtar, Z.	1	2	1
Albayrak, E.	1	10	4

The bibliometric analysis included a review of 97 sources and academic journals that published works related to the flipped classroom technique applied to the development of student autonomy. As shown in Table 2, the most relevant sources were BMC Medical Education and Education Sciences, each with five published documents. They were followed by Education and Information Technologies, European Public and Social Innovation Review, and International Journal of Emerging Technologies in Learning, each with four publications.

Moreover, it is important to highlight that most of these sources have a high impact factor, placing them in the upper quartiles of their respective fields. This reflects not only the quality but also the relevance and prestige of the publications addressing this topic, thereby consolidating a solid foundation for research in the field of the flipped classroom and autonomous learning.

Table 2

Sources or journals with highest scientific productivity

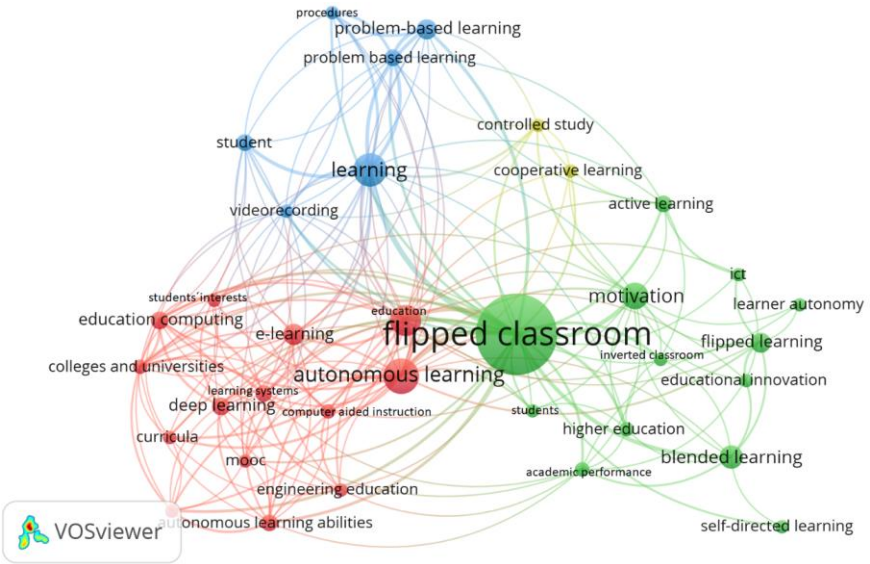
Source or Journal	Number of Documents	Source or Journal	Number of Documents	Source or Journal	Number of Documents
BMC Medical Education	5	Heliyon	2	Afinidad	1
Education Sciences	5	Innovations in Education and Teaching International	2	Agro Food Industry Hi Tech	1
Education and Information Technologies	4	Journal of Engineering Education Transformations	2	Applied Soft Computing	1
European Public and Social Innovation Review	4	Journal of Higher Education Theory and Practice	2	Asia Pacific Education Researcher	1
International Journal of Emerging Technologies in Learning	4	Journal of University Teaching and Learning Practice	2	Australasian Journal of Educational Technology	1
Asia Pacific Education Review	3	Kuram Ve Uygulamada Egitim Bilimleri	2	Boletín de Malariología y Salud Ambiental	1
Boletín Técnico Technical Bulletin	3	Mobile Information Systems	2	Central European Journal of Engineering	1
Frontiers in Psychology	3	Pixel Bit Revista De Medios Y Educación	2	Chinese Journal of Biochemistry and Molecular Biology	1
BMC Nursing	2	Revista de Educación	2	Chinese Journal of Nursing Education	1
Chinese Journal of Evidence Based Medicine	2	Scientific Programming	2	Chinese Journal of Parasitology and Parasitic Diseases	1
Computational Intelligence and Neuroscience	2	Sisal Journal	2	Chinese Journal of Schistosomiasis Control	1
Computer Applications in	2	Theory and Practice in Language Studies	2	Cogent Education	1

Engineering Education					
Computers and Education	2	Acta Didáctica Norden	1	Total revistas	97

The keywords selected by the authors are represented in Figure 2 and are grouped into three clearly differentiated categories. To compile the presented data, documents were chosen whose titles, abstracts, or keywords appeared more than three times. To more clearly illustrate the three identified groups according to the degree of association predicted by VOSviewer, a co-occurrence network was constructed in which the keywords were colored distinctly to indicate each category. Thus, one way to appreciate the degree of clustering is to observe the total number of records, represented by the lines connecting the labels.

- **Green cluster:** centered on the term "flipped classroom" (124 occurrences), it is associated with words such as active learning, motivation, ICT (Information and Communication Technology), student autonomy, flipped learning, innovation in education, higher education, academic performance, blended learning, self-directed learning, and students.
- **Red cluster:** based on "autonomous learning" (72 occurrences), this cluster includes keywords related to education, e-learning, educational technology, student interests, colleges and universities, learning systems, deep learning, computer-assisted instruction, curricula, MOOCs (Massive Open Online Courses), engineering education, and autonomous learning capabilities.
- **Blue cluster:** linked to the term "learning" (60 occurrences), this cluster groups related words such as student, video recording, procedures, problem-based learning, controlled study, and cooperative learning.

Figure 2
Co-occurrence of keywords



Through bibliometric mapping, a notable diversity of countries with high levels of scientific production was identified by analyzing the reviewed documents across various thematic areas. In total, 35 countries contributed to the publication of articles, according to the authors' affiliations. As shown in Figure 3, China leads production with 57 works, representing 35% of the total. Following are Spain, with 29 publications (17.8%), and Taiwan, with 9 works (5.5%).

On the other hand, regarding the language of the publications, English predominates overwhelmingly, accounting for 83.3% of the total, followed by Spanish at 10.4% and Portuguese at the remaining 6.3%.

Figure 3
Productivity by country of origin

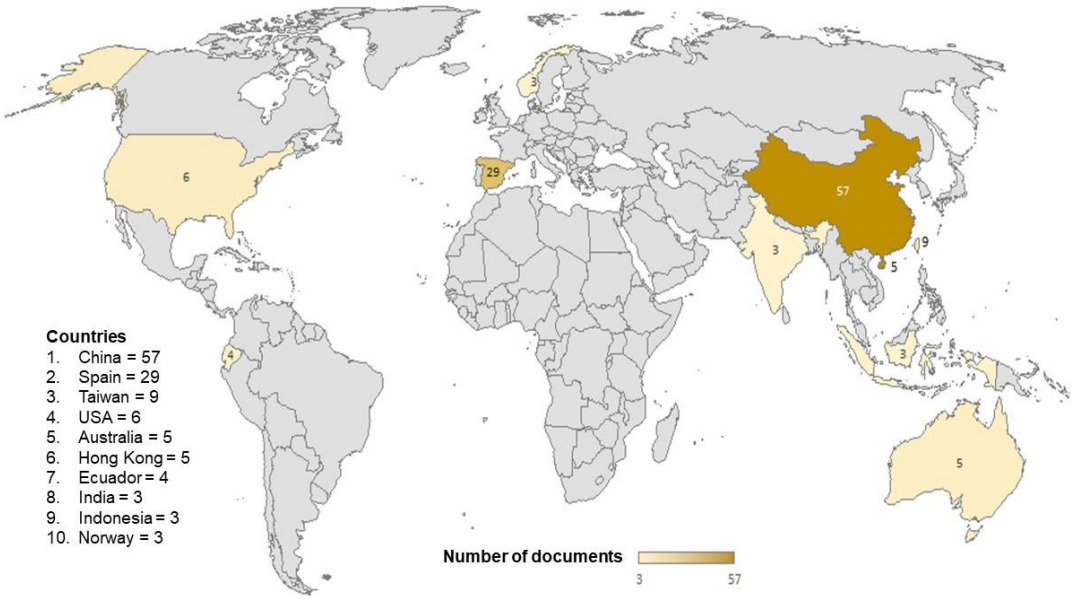


Table 3 presents all documents published on the flipped classroom as a strategy to promote autonomous learning, covering the period from 2013 to 2025, organized by thematic area and type of publication. In terms of thematic fields that concentrate total scientific production, social sciences represent 38%, followed by computer science at 14.3% and engineering at 8.9%.

A more detailed analysis by document type reveals that the vast majority, 93.1%, corresponds to scientific articles. In contrast, book chapters constitute 6.3% of the total, while complete books represent only 0.7%.

Table 3
Publication of documents by thematic area and type

Thematic area	**Number of documents**	**%**
Social Sciences	98	38.0%
Computer Science	37	14.3%
Engineering	23	8.9%
Arts and Humanities	14	5.4%
Psychology	14	5.4%
Medicine	11	4.3%
Economics, Econometrics, and Finance	8	3.1%
Health Professions	7	2.7%
Materials Science	7	2.7%
Mathematics	7	2.7%
Document Type	**Number of documents**	%
Article	134	93.1%
Book Chapter	9	6.3%
Book	1	0.7%

Through bibliometric mapping, it was evidenced that the flipped classroom model empowers students by reversing the traditional dynamics between teacher and student, granting greater prominence to independent learning (Quingalahua et al., 2023). In this framework, autonomous learning is defined by the students' ability to self-regulate, meaning to organize, monitor, and evaluate their own academic progress (Fuentes-Riquero, 2025). Unlike conventional models, the flipped classroom promotes this self-regulation by assigning students greater responsibility for time management, material comprehension, and active participation in class (Domínguez-Rodríguez & Palomares, 2020).

As a relevant area of study, bibliometric reviews allow for the categorization and analysis of existing academic work, revealing patterns, critical themes, and key findings in research. According to bibliometric statistics, publications employing the flipped classroom model as a means to promote autonomous learning have experienced exponential growth since 2020. In this context, one of the most prominent authors is Lin, C.J., from the National Taichung University of Education in Taiwan, who has investigated topics such as the assessment of learning activities based on mind mapping and the analysis of variables affecting the performance of English students in flipped classrooms (Lin, 2018; Lin, 2019).

Similarly, the journal BMC Medical Education has shown a notable trend with the publication of five documents in areas such as social sciences and medicine. Among these works are studies on the application of the flipped classroom model based on the CDIO framework in clinical nursing education (Su et al., 2023), the flipped classroom method in clinical learning for neurology residents (Zhang et al., 2024), and the implementation of the flipped classroom in biochemistry education (Ji et al., 2023), among others. Additionally, research conducted by international teams indicates that China leads scientific production on this topic, focusing on aspects such as the effectiveness of the flipped classroom in enhancing autonomous learning capacity (Yang & Chen, 2024), the combination of the flipped classroom with music and deep learning (Zhu et al., 2023), the integration of the flipped classroom with problem-based learning (Chi et al., 2022), and the enhancement of teaching through flipped classrooms supported by virtual reality for deep learning in schools (Dai & Kang, 2025).

This approach also explains why universities and institutions have adopted the flipped classroom in recent years: to overcome traditional methods and focus education on the student (Montenegro et al., 2024). By facilitating the development of skills such as independence, self-control, and responsibility, this model encourages students to take a more active role in their educational process. In this scenario, the role of the educator transforms from being the primary transmitter of knowledge to acting as a facilitator, guiding, supporting, and providing constant feedback (Araya-Moya et al., 2022). For this reason, higher education institutions promote the incorporation of active techniques like the flipped classroom in their teacher training programs, alongside other pedagogical approaches such as collaborative work and problem-based learning (Alvarracín et al., 2022; Bracho et al., 2023).

In this sense, bibliometric research supports the idea that the flipped classroom model fosters student autonomy in learning (Cabrera et al., 2021). Furthermore, studies conducted in countries such as the United States, Hong Kong, China, Taiwan, Spain, and Australia have demonstrated that students utilizing this methodology show a greater commitment to their education and a higher motivation for achieving success. It has also been evidenced that when this approach is combined with formative assessments and constant feedback, it enhances both academic performance and students' self-assessment abilities (Rodríguez-Jiménez et al., 2024).

In summary, global research has confirmed that the flipped classroom model has significant potential to promote more independent study habits (Alarcón & Alarcón-Díaz, 2021). However, its effective implementation depends on the careful consideration of various factors, such as teacher training, pedagogical strategy, student context, and institutional support (Pinenla-Palaguaray et al., 2024). By transforming traditional classroom dynamics, this model helps create a more flexible, participatory, and adaptable educational culture that can meet the challenges of the modern era (Ordoñez et al., 2024).

Conclusions

Studies examining the flipped classroom model as a means to foster autonomous learning among students have significantly increased in recent years, aligning with the declared objective of this analysis. By reviewing all works indexed in Scopus between 2013 and 2025, the bibliometric analysis revealed a 35.4% increase (n=51), particularly highlighting the period from 2020 to 2024 as the one with the highest scientific production. In this context, China stood out with 35% of the total production (n=57), positioning itself above the other studied

countries. Furthermore, 83.3% of the publications were published in English, reflecting the predominance of this language in academic dissemination.

Regarding the most influential authors, Lin emerged as the most cited, accumulating 174 citations across two articles published in 2018 and 2019, respectively. Additionally, BMC Medical Education was identified as the most relevant source, with five academic works published. In terms of document type, scientific articles accounted for 93.1% of the total, while 38% of the research focused on social sciences.

In conclusion, it can be asserted that there is a sustained trend in the publication of scientific studies on the flipped classroom as a method for promoting autonomous learning. This is evidenced not only by the identification of prominent authors and the geographical dispersion of production but also by the collaboration between institutions and the diversity of thematic areas addressed. Therefore, this study reinforces the argument that the flipped classroom model constitutes a powerful tool for transforming educational dynamics, especially when used to motivate students to strengthen their autonomy, foster critical thinking, and enhance long-term knowledge retention. Consequently, this bibliometric analysis establishes a solid foundation for future research in this field.

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